EMI ENCLOSURE HAVING A FLEXIBLE CABLE SHIELD

Field Of The Invention

[0001] The invention relates to the electromagnetic interference (EMI) shielding arts. It finds particular application to an enclosure for an electronic device where the enclosure includes a flexible cable shield. It will be appreciated that the present invention will find application in any electronic system where shielding of EMI is desired including mainframe computers, network servers and the like.

Background Of The Invention

[0002] Electromagnetic interference (EMI) is a common problem faced during the operation of electronic equipment. EMI is unwanted electromagnetic energy entering or emitting from a specific piece of electronic equipment, thereby causing interference. EMI can cause that piece of electronic equipment or electronic equipment nearby to function improperly or to not function at all.

[0003] Typically, electronic equipment is housed within a metallic enclosure to help reduce EMI problems. Metallic materials are electrically conductive which serve to block EMI. However, joints or other openings in the enclosure tend to provide a source of radiation leakage and thus cause a reduction in shielding effectiveness. Conventionally, this reduction has been ameliorated by the use of

electrically conductive compliant gasket material trapped between the lid or panel and the rest of the enclosure. When the enclosure has cables passing though an opening, a conduit was typically provided to enclose the opening and the cables. Prior art conduits were made of stiff metal that were difficult to work with and required additional tools to install and configure to various cable sizes.

[0004] The present invention provides a new and useful enclosure that cures the above problems and others.

Summary Of The Invention

[0005] According to the present invention, an enclosure is provided that includes a housing that reduces electromagnetic interference. The housing includes an opening to allow one or more cables to pass therethrough. A flexible cable shield, formed as a conduit, has a first and a second end. The cable shield has a inner surface formed of an electrically conductive flexible material that reduces electromagnetic interference. The first end is secured to the enclosure and encloses the opening. The second end is adjustably closable to closely surround one or more cables passing therethrough causing the inner surface of the flexible cable shield to contact the one or more cables.

[0006] One advantage of the present invention is that installing and shielding different quantities and/or sizes of cables in an enclosure is easily performed.

[0007] Still further advantages of the present invention will become apparent to those of ordinary skill in the art upon reading and

understanding the following detailed description of the preferred embodiments.

Brief Description Of The Drawings

[0008] In the accompanying drawings which are incorporated in and constitute a part of the specification, embodiments of the invention are illustrated, which, together with a general description of the invention given above, and the detailed description given below, serve to example the principles of this invention.

[0009] Figure 1 is an exemplary perspective view of an enclosure with two flexible cable shields in accordance with the present invention;

[0010] Figure 2 is a cross-section view of the cable shield showing a two layer structure in accordance with the present invention;

[0011] Figure 3 is an exemplary view of Figure 1 with the front wall panel removed;

[0012] Figure 4 illustrates the attachment end of the cable shield formed into flaps that fold around a gasket in accordance with the present invention;

[0013] Figure 5 is a cross-section view of the cable shield attached to the enclosure wall in accordance with the present invention; and

[0014] Figure 6 is a cross-section view of the cable shield being closed around cables in accordance with the present invention.

Detailed Description Of Illustrated Embodiment

[0015] The following includes definitions of exemplary terms used throughout the disclosure. Both singular and plural forms of all terms fall within each meaning:

[0016] "Electromagnetic interference" also referred to as "EMI", as used in this disclosure, is understood to refer to electromagnetic emission and radiation that includes both electromagnetic interference (EMI) and radio-frequency interference (RFI). It also refers to other types of radiation that can interfere with the operation of nearby electrical equipment as know to those skilled in the art.

[0017] "Resilient", as used in this disclosure, is understood to refer a characteristic of a material that is deformable and capable of withstanding shock without permanent deformation or rupture. It also includes having a tendency to recover from or adjust to a change in shape.

[0018] "Conduit", as used in this disclosure, is understood to refer an enclosed channel through which something may pass. The conduit includes any desired cross-sectional shape or configuration such as round, elliptical, flat, square, rectangular, triangular, other shapes or combinations of shapes at different points along the conduit.

[0019] Illustrated in **Figure 1** is an enclosure **100** that is used to enclose electrical devices to reduce electromagnetic interference (EMI) to and/or from the electronic device, such as a central processing unit. The enclosure **100** includes a housing **105** formed of one or more walls made of an electrically conductive material, for example, sheet metal. As shown, the wall is a two panel wall where a first panel **110** and a second

panel **115** are secured together. It will be appreciated that any number of panels can be used to form the enclosure walls including one panel. Once the enclosure **100** is installed in a product enclosing an electronic device(s) therein, the enclosure reduces the transmission of electromagnetic interference to and from the enclosed device. Exemplary products that the enclosure can be used in include a mainframe computer, network server or other electronic systems.

[0020] The enclosure **100** is constructed to minimize the number of openings in the enclosure since an opening may allow EMI to leak through. However, certain enclosed electrical devices have one or more cables connected to them in order to transmit and receive signals from other electronic devices. To allow one or more cables to enter the enclosure **100**, an opening **120** is formed through the enclosure which is best seen in **Figure 5.** To prevent passage of electromagnetic interference through the opening **120**, a flexible cable shield **125** is attached to the enclosure **100**. In particular, the flexible cable shield **125** is a conduit and has a first end **130** that surrounds the opening **120** and is secured to the enclosure **100** to minimize leakage of electromagnetic interference. The flexible cable shield **125** extends out from the enclosure **100** and terminates at a second end **135** that is open. Although **Figure 1** is illustrated with two cable shields **125**, it should be appreciated that any number of cable shields can be attached to the enclosure **100** including one shield.

[0021] The flexible cable shield **125** is formed of a flexible, electrically conductive fabric **140** that forms the inner surface of the cable shield **125**. A flexible, electrically non-conductive outer layer **145** is bonded to the conductive fabric **140** to provide support to the fabric **140**.

The non-conductive layer **145** is, for example, neoprene or any desired polyurethane, elastomer, foam, cellular structured material, synthetic rubber or the like that is flexible and resilient.

[0022] The electrically conductive fabric **140** is, for example, identified by the trademark Z-Cloth® made by the Zippertubing Company of Los Angeles, California. This material is a woven substrate of polyester fabric, which is subjected to an electro-less plating process. The fabric is chemically plated with copper, nickel or a combination of both to produce conductive fibers. The type of metal and depth of plating determine the fabric's inherent electrical conductivity. Density of weave, combined with fiber conductivity, determines the overall surface resistively and shielding effectiveness.

[0023] The conductive fibers of the fabric **140** can be other types of metal fibers, metal alloy fibers, metallized synthetic fibers, such as metal plated nylon fibers, or the like. The conductive fibers are embedded in or coated on the fabric **140** in an amount sufficient to form an electrically conducting layer while also maintaining flexibility of the fabric **140**. This yields a conductive fabric which is flexible in three dimensions. With these properties, the flexible cable shield **125** is adjustable, for example by squeezing, to closely surround and contact any number of cables or cable sizes to minimize electromagnetic interference.

[0024] Illustrated in Figure 2 is a cross-section view of the shield 125 showing a two layer structure. An example of a material with both the inner layer **140** and outer layer **145** as described above is product number Z-3250CN, identified by the trademark Z-Shield®, made by the Zippertubing Company of Los Angeles, California. Z-3250CN is a

combination of a polyurethane film **145** bonded to a metallized fabric **140**. Of course, the shield **125** can be made with any number of layers including one layer.

[0025] With reference to **Figure 3** , the wall of the enclosure **100** is shown with the first panel **110** removed. A bracket **300** supports and secures the first end of the flexible cable shield **125** to the panel wall **115**. The bracket is made from an electrically conductive material, for example metal. To minimize any openings through which EMI may leak, a gasket **305** surrounds the cable opening **120** and is positioned against the cable shield's first end **130**. To create a flat, attachable surface from the shield **125**, the end **130** is cut in one or more locations. As best seen in **Figure 4**, the cuts create one or more flaps such as flaps **130a, 130b, 130c** and **130d**. Of course, any number of flaps can be made. The first end **130** is secured to the gasket **305** by, for example, folding the flaps around the gasket **305** as shown in **Figure 4**. One or more holes **400** are then formed therethrough to receive rivets or other securing device as described below. The flaps allow the cable shield to completely surround the cable opening **120** in 360 degrees.

[0026] With reference again to **Figure 3**, the bracket **300** is riveted to the panel **115** with the gasket **305** and the cable shield's flaps **130a-d** positioned therebetween. This compresses the gasket and the flaps against the panel **115** minimizing any openings and securing the cable shield **125** to the enclosure **100**. In particular, the bracket **300** includes two securing flanges **310, 315** that extend around the perimeter of the bracket. Flange **310** secures to the first wall panel **110** (not shown) and flange **315** secures to the second wall panel **115**. The flange **315** is positioned over the cable shield's first end **130** and over the gasket **305**,

and is secured to the second panel **115** by rivets **320**. It will be appreciated one skilled in the art that the bracket **300** can be secured to the enclosure wall using a variety of methods such as welding, bonding, screwing and the like.

[0027] Illustrated in **Figure 5** is a cross-section view showing the attachment of the cable shield **125** to the enclosure wall **115**. As seen in the figure, the end **130** of the cable shield **125** is folded around the gasket **305** and compressed against the wall **115** by bracket flange **315**. The other panel wall **110** is secured to the wall **115** by being attached to the bracket flange **310**. It should be appreciated that the flexible cable shield **125** can be attached to the enclosure wall in other ways than the illustrated embodiment. For example, the enclosure **100** can have a single panel wall and the bracket **300** would not require two flanges. Additionally, the first end **130** of the cable shield can be attached to the opposite side of the enclosure wall **115** so that the cable shield **125** passes through the opening **120**. In this configuration, the cable shield's open end **135** is disposed on the opposite side of the enclosure wall **115** than the attached end **130**. Additionally, the cable shield's first end **130** may be attached without being folded around the gasket **305**.

[0028] Illustrated in **Figure 6** is a cross-sectional view of a plurality of cables **600** passing through the cable shield **125** and into or out of the enclosure **100**. The cable shield's open end **135** is cinched closed with one or more straps **605** or other tying device. The flexibility and resiliency of the cable shield **125** allows it to closely surround the cables **600** regardless of the number of cables or their size. Closing the cable shield **125** causes the electrically conductive fabric **140**, which is on the inner surface of the cable shield, to contact the cables **600** around their

perimeter. Most cables have an external conductive shield surrounding it in 360 degrees. At the points of contact with the fabric **140**, the cables should have 360 degrees of exposed shield to maximize conductivity. To maximize the EMI shielding ability, the far end of the cable shield on **600** should make a 360 degree electrical connection to a metallic enclosure with similar EMI shielding properties.

[0029] If an insulator is present around the cable, it should be stripped back or removed to expose the conductive shield so that contact with the conductive fabric **140** can be made. The contact creates an electrically conductive path between the cables **600**, the conductive fabric **140**, and the enclosure **100** which reduces electromagnetic interference from being transmitted to or from the cables and to or from the opening **120** of the enclosure **100**. Reduction occurs by providing a return path for the electromagnetic currents to its source verses absorption of the energy by a ferrite or other lossy material. Optionally, an EMI absorbing material can be wrapped around the cables to provide additional shielding properties by absorbing energy. EMI absorbing material is known in the art and is, for example, material produced by Cuming Microwave Corporation.

[0030] When no cables are present, the flexible cable shield **125** can close the opening **20** in a "stand alone" product by closing it's end **135** against itself. In other words, it can plug the EMI opening **20** in a system configuration with no external cables passing through. The flexible and resilient properties of the shield **125** allow adding external cables in the future simply by opening it, installing cables, and closing it.

[0031] The present invention also provides the ability to have adjustable termination points, where a termination point is the point at which the cable shield **125** is strapped closed into contact with the cables. Since the cable shield is flexible, it can be terminated at any one or more desired points along its length (e.g. terminate it every 12 inches, but this depends on the specific application). This is advantageous because a common cable length can be installed throughout the electronic device (e.g. at least as long as the longest required length). For shorter lengths, the excess cable can be stored within an adjacent enclosure. It is convenient to have a common cable length for installation and repairs because it is easier order a single cable length than have to measure and order many different lengths.

[0032] With the present invention, configuration and installation of an EMI enclosure with cables passing therethrough is done quickly and easily. The flexible cable shield provides shielding of cables without requiring additional tools to configure the cable shield to enclose cables. The present invention provides an adjustable resilient system for enclosing any number of cables and sizes passing through the enclosure simply by collapsing and/or constricting the cable shield around the cables with a tying device. In this manner, the open end of the shield is easily configured to any size to closely surround and contact the cables. Additionally, the resilient properties of the shield allow it to be opened and closed multiple times without extensively damaging the shield.

[0033] While the present invention has been illustrated by the description of embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicants to restrict or in any way limit the scope of the appended claims

to such detail. Additional advantages and modifications will readily appear to those skilled in the art. For example, the cable shield **125** can have a single layer of material or have multiple layers of materials beyond the two layers described herein. Therefore, the invention, in its broader aspects, is not limited to the specific details, the representative apparatus, and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of the applicant's general inventive concept.